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A RÉSUMÉ OF SOME MODERN METHODS OF THE DIAGNOSIS OF DISEASES OF THE STOMACH.

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THERE is in medicine no subject the study of which can be approached with a livelier degree of interest and satisfaction by the clinician than that of diseases of the stomach. Under modern methods of research, these ailments offer an extended range for profitable inquiry, and a scope, the result of exploration, which is not alone of interest to the investigator, as is unfortunately often the case with the familiar organic affections of certain other organs —such, for example, as those of the nervous system. These, though of absorbing satisfaction to follow through their intricacies of diagnosis, are—and probably ever will be—almost a barren field to the therapeutist. The end for which we gain our knowledge—the cure of disease—is in affections of the stomach less hampered by "the old and inevitable antagonism between pathology and therapeutics"[1] than in ailments of any other viscus.

Recent diagnostic methods, aided by the teaching

[1] Gowers: Syphilis and the Nervous System.

of the laboratory, not only often enable us to arrive at the nature of the disorder with an astonishing degree of exactness, and to formulate a therapy most successful in result, but they also render it as unnecessary as it is impossible to wait for post-mortem revelations as to the nature of the pathologic process. In diseases of the stomach, in which the workings of a disordered viscus can be studied and compared with the normal, we are enabled to learn so much regarding the pathology of curable diseases, that the reproach, often just, that modern scientific medicine has the tendency to create a greater interest in the study of a disorder than is taken in the patient's well-being, cannot hold here.

The diagnostic methods of inspection, palpation, and percussion, applied to the study of stomach diseases, need not be here detailed, their general application being understood. Regarding palpation, two points, upon which especial stress should be laid, may be noted in passing: (1) that it should always be performed with the hand placed horizontally upon the abdominal wall, and never with it held perpendicularly or obliquely; and (2) that when palpation in dorsal recumbency is resultless, an examination in the knee-elbow and lateral position should not be omitted. It is often necessary that these external methods of examination should be conducted under artificial distention of the stomach, either alone or, conjointly, of the large bowel, with gas or water—or, when the combined method is used, one viscus may be distended with gas, the other with water.

The stomach, more especially its inferior margin,

may be outlined when empty and the patient erect, by first noting the lower line of tympanitic note its percussion evokes, if it be possible to thus differentiate transverse colon and stomach. A pint or more of water is now introduced, and if necessary the colon distended with air by a hand-ball syringe, or by the inverted siphon of a bottle of carbonated water. The method of Dehio, a modification of this, is of still greater utility. About a quart of water is introduced in separate quantities of a half-pint each, and after the ingestion of each portion, the lower crescentic limit of flatness against the tympanitic transverse colon is outlined. In the erect posture, though the normal stomach descends somewhat with the increased amount of fluid introduced, it will not quite reach the level of the umbilicus. In cases of relaxed muscularis the descent is more rapid, and in pronounced ectasia and in gastroptosis the stomach is already abnormally low before the introduction of fluid. Another method employed is, with the patient recumbent, to distend the colon with water and the empty stomach with gas, either by generating it *in situ* by the administration separately of the acid and alkaline portions of one or two Seidlitz powders[1] in concentrated solution, or by the introduction of air through a stomach-tube by an ordinary enema-syringe. The former is a more rapid method of obtaining distention, but often not quite so satisfactory in result when applied in cases of decided gastrectasia.

[1] A teaspoonful or two of sodium bicarbonate and about two-thirds this quantity of tartaric acid may be used to replace the Seidlitz powder.

Among the newer methods of exploration must be mentioned gastrodiaphany of Einhorn.[1] With this, valuable aid may be obtained in outlining the size, situation of the stomach, and, in certain cases, the condition of the anterior gastric wall. Einhorn's gastrodiaphane, made by Reynder & Co., of New York, consists of a soft stomach-tube, at the gastric extremity of which is placed an Edison's hard-glass lamp, from which conducting wires, containing a current-interrupter, run to a portable storage-battery. This apparatus, which is really very practicable, is as easy of introduction and manipulation as the ordinary stomach-tube. In its application the stomach should be free from food and moderately distended with water.[2] When considerable faucial irritability exists a cocaine solution should be first applied to the throat.[3] The stomach extremity of the gastrodiaphane, after being lubricated with oil or glycerin, is guided over and past the epiglottis by the index-finger of the left hand,

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[1] See the New Yorker med. Monatsch., November, 1889; the New York Med. Journ., December 3, 1892.

[2] Einhorn advises from one-half to one pint. Heryng and Reichmann (Therapeutische Monatshefte, March, 1892), who have recently investigated gastrodiaphany with a special apparatus of their own, find that the most satisfactory results are obtained when the stomach is *filled* with water. They use, according to the degree of dilatation, from 500 to 2000 c.cm. My own experiments with Einhorn's gastrodiaphane have given me much better results when the stomach was distended with water.

[3] As it is usual to examine the gastric contents in cases in which diaphanoscopy is indicated, the patient has probably become somewhat accustomed to the application of the soft tube. This I regard desirable when it can be arranged, as nervousness and gastric irritability will not then disturb the examination.

much as a hard tube is introduced. After its passage, the circuit is closed. If no pronounced thickening of the anterior stomach-wall exists, trans-illumination in a dark room, with the patient erect, permits the outlines of the stomach to be seen as a zone of reddish hue on the abdominal wall.

The actual utility of gastrodiaphany over other methods of outlining the stomach lies especially in the application of the diaphanoscope to the differentiation of gastroptosis from gastrectasia, as by it the determination of the site of the lesser curvature is far more readily made than by inflation. It also is of real value in diagnosticating tumors or thickening of the anterior wall of the stomach, the presence of these interfering with trans-illumination.[1]

The most notable of the advances made in the diagnosis and treatment of diseases of the stomach dates from the application of the stomach-tube to diagnostic purposes by Leube, in 1871, and the subsequent introduction of the soft tube by Ewald, for similar uses. An insight was thus obtained better than ever before as to the gastric chemism, and extraordinary opportunity given not only to study its derangements in various phases, but for experimental research leading to a rational therapy. The time has now, indeed, arrived in which it may be not rashly asserted that one might as readily attempt to diagnosticate a grave kidney-derangement without an examination of the urine, as some of the common gastric ailments, without at least a cursory study of the secretory condition of the dis-

[1] Einhorn relates a case of probable diffuse carcinoma, in which the diagnosis was so established.

eased stomach. Beyond doubt, less hazard will result from such empiricism applied to the management of derangements of the kidney than to that of those of the stomach, the constant disorder of which may be regarded as *fons et origo* of many of the chronic ills that appear with increasing years. Fortunately, the use of the tube for diagnostic purposes, and the subsequent examination of the removed stomach-contents, require so little special skill that these are the reach of even the medical tyro.

The best form of stomach-tube is that of Ewald. This is of moderately soft red rubber, of open and somewhat tapering tip. It has in the lateral walls one large fenestra, and a number of smaller ones.[1]

The tube of Ewald, as sold, is of insufficient length for lavage. When used for this purpose, a second portion of gum tubing must be joined by the interposition of a small section of glass piping. For a mere removal of the stomach-contents the length is ample without the second piece of tube, except in cases of gastrectasis.

So important an adjuvant to diagnosis and treatment is the tube, that I consider it almost impossible

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[1] The inner edge of the large opening in the lateral wall should be bevelled. Even with the 11 mm. tube, the full size, I often have had difficulty in removing the stomach-contents after a general meal, in which imperfect solution of the food has occurred. Large portions of mucus alone will sometimes block both the tip and lateral fenestræ. Cheaper, softer tubes than Ewald's are generally sold in this country. These are of red rubber, about 60 inches in length. They have an open tip, and a fenestra in the lateral wall. Their other extremity is made funnel-shaped.

to do justice to a case of pronounced chronic gastric disorder without a resort to it in some stage of the disease. So helpful is it in arriving at a correct diagnosis, and in directing the therapy, apart from its utility for lavage, that the earlier a patient can become habituated to its employment the better. I now rarely treat a case without it, and as rarely encounter one that will not willingly consent to its use for diagnostic purposes and treatment, when its utility is explained. But a few introductions of the tube are required—the throat cocainized[1] at first, if necessary, and the intervals not too lengthy—before the patient will most readily manipulate it totally without inconvenience, and always, in selected cases, with benefit.

The stomach-contents are more readily removed with less disturbance to the patient by aspiration than by the expression method of Ewald, now com-

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[1] A small quantity of a low percentage of cocaine (about 3 to 4) is projected with a medicine-dropper upon the posterior pharyngeal wall, shortly before the tube is passed. I always make use of cocaine in this way, especially in women, the first two or three times. Subsequently cocaine may be dispensed with. The gummy smell of the tube, after introduction, is offensive to some, and may in itself produce nausea. A few drops of mentholated oil snuffed into the nostrils disguises this. After a few introductions the odor is no longer objectionable. After cocainizing the throat the stomach extremity of the tube is rapidly passed toward the pharynx, the patient being directed to swallow as it engages in the latter. With one or two efforts at deglutition the tube can then usually be pushed rapidly onward until it reaches the stomach's fundus. It is unnecessary to introduce the finger into the mouth in passing the soft tube, guidance past the epiglottis not being required. The whole maneuver, introduction of tube and siphonage, can be accomplished usually in a few seconds.

monly recommended. The latter is often difficult of successful application in uneducated cases, and is, moreover, annoying to the patient. Frequently, also, by it the entire stomach-contents cannot be removed, so necessary for a complete examination when a small meal, such as a trial-breakfast, has been taken. There is also likelihood of a reflux from the duodenum of alkaline juices in cases of relaxed pylorus, when straining efforts of evacuation are made, besides the actual danger of hemorrhage in cases of unsuspected ulcer. I now invariably use for aspiration a simple apparatus, which can be readily made by anyone. It consists of a wide-mouth bottle of moderate capacity, with a rubber stopper containing two perforations, holding glass tubes, the outer extremities of which are bent at a right angle; to these are attached the stomach-sound and a simple rubber bulb, or, preferably to the last, an ordinary enema syringe, minus its metal or hard-rubber extremity. With the bulb or syringe a rapid exhaust of air in the bottle is produced, the latter being held below the stomach-level. A prompt inflow of gastric contents then usually promptly occurs without gastric disturbance. Should the flow not occur promptly, or, having begun, have ceased, the intra-gastric extremity of the tube being at the fundus, the exhaust syringe should be reversed, and several bulbfuls of air pumped into the stomach. Thus, any food particles or masses of mucus which may have blocked the fenestræ will be dislodged. The syringe is then reversed and the aspiration completed. The bottle, stopped with an ordinary cork, serves to transport the stomach-contents,

should the aspiration have been done away from the place of examination.

Many and careful studies of the gastric secretory function during fasting and in various periods of digestion, first undertaken by Ewald and Boas, and subsequently pursued by many others, with results in the main confirmatory of those obtained by the former, have shown that normally during fasting the stomach contains no digestive secretion;[1] and that after food, certain definite stages of digestion occur, during which, with very similar quantity and character of aliment, similar intra-gastric conditions will be encountered, and that if broad deviations occur from these an abnormality is indicated. A variety of trial-meals have been suggested to ascertain this, such as Ewald's, Leube and Riegel's, Reichmann's, and Jaworski's,[2] any one of which resorted to, must

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[1] Apparent exceptions to this exist only in those in whom manipulation excites a flow of gastric juice, or, in cases of hyper-secretion, in which, during fasting, the stomach often contains more or less gastric juice, the acidity of which is often higher than that of the normal.

[2] That in common use is Ewald's, consisting of a well-cooked stale roll (or 35 to 70 grams of stale white bread), without butter, and 300 c.cm. of water, or an equal quantity of weak tea without milk or sugar.

Leube and Riegel's dinner, of which the other trial-meals are modifications, consists of 400 c.cm. of soup; 60 or more grams of scraped beef; 50 grams of white bread, and 200 c.cm. of water. It is less convenient of administration than Ewald's, and is likely to be much more difficult of removal than the others, when digestion is retarded.

Reichmann's breakfast consists of 30 grams of meat-powder; 2 grams of salt; 200 c.cm. water, and one wheaten roll.

Jaworski uses the whites of two hard-boiled eggs, and 100 c.cm. of water.

invariably be ingested on an empty stomach. Whichever is selected, it is desirable that that one only should be habitually used, as different varieties and quantities of food do not stimulate the secretory function equally.

The stomach-contents should be removed at a time when digestion is normally at its height, which occurs after Ewald's breakfast in from three-quarters of an hour to one hour; after Riegel's meal in from three to five hours, and in about one and a half hours after Reichmann's.

During the early stage of the digestive phase the acidity of the gastric contents is feeble, due to acid salts of the ingesta, and to lactic acid, the latter derived either from the lactates in the food or from fermentation of carbohydrates. In this stage, varying from twenty minutes to two or more hours, depending upon the amount and character of the ingesta, saccharification of starch, begun in the mouth, occurs, and continues so long as the acidity due to organic acids and acid phosphates remains at a minimum. The second stage is characterized by the appearance of uncombined HCl, after complete saturation by the latter of organic bases and albuminoids.[1] Free HCl now gradually increases in amount until the normal percentage—

[1] By free HCl is meant that not united as a salt with the organic bases of the ingesta, or loosely combined with the albuminoids. The latter represents the bound or united HCl, not detectable by qualitative tests. See my paper in Hare's System of Therapeutics, vol. ii, p. 890.

0.15 to 0.3[1]—is reached, while lactic acid and acid salts coincidently diminish, and finally disappear, except in traces too minute to be appreciable by ordinary tests.

After a light meal, such as Ewald's trial-breakfast, the reaction for free HCl is usually manifest to ordinary tests in from twenty to forty-five minutes, and at the latter period in the percentage stated. At the height of digestion of a more varied meal the percentage of free HCl may be even greater than this normally; and contrarily, in diseased conditions may also be much less, depending upon the readiness with which the secretory function responds to increased stimulation. The reaction for starch is then normally absent, but that for erythrodextrin and grape-sugar is decided. Tests for ordinary albumin also result negatively, while, contrary to what is ordinarily regarded as the rule, there is an abundance of proteoses, but traces only of peptone, if present at all. The formation of abundant proteoses (albumoses) indicates sufficiently the presence of pepsin, while the existence of lab-ferment is evinced by the ability of the filtrate of the removed contents to solidify milk.

A systematic examination of the gastric secretion is best conducted as follows:[2] The stomach-contents, removed at the time already specified, are carefully inspected as to the presence of blood, bile,

[1] 0.3 per cent. of free HCl is often present physiologically at the height of digestion of a full meal.

[2] Lack of space prevents the subject being here considered other than in outline. It is, however, sufficiently detailed for practical clinical purposes.

mucus, and evidences of solution of food. It is now subjected to thorough agitation in a small vial, preceding filtration, if the latter is practised, as it has been ascertained that different portions of the filtrate are sometimes of varying acidity.[1] Examination should be made as early as possible after removal of the contents, that further digestion or fermentative processes may not ensue, perhaps resulting in disappearance of the free HCl present.

The acidity is first ascertained by litmus or Congo paper.[2] Congo paper may be first used, since, because of its reacting to free acids and abnormal amounts of acid salts, rendering blue or violet the former and weakly browning the latter, a positive response obviates the use of litmus, and often gives valuable preliminary testimony.

The total acidity—that due to free acids and acid salts—is now determined. Ten c.cm. of the stomach-contents are titrated with a deci-normal solution of

[1] See "Die Magensaüre des Menschen," Martius and Lüttke. For this reason it is advisable to make quantitative examination for HCl and for the acidity, without filtration. When filtration is practised, thorough agitation should first be made. I have recently applied the centrifugal machine used for prompt separation of precipitates in urine, for quickly obtaining the fluid portion of the stomach-contents, after thorough shaking to insure an equable mixture.

[2] Congo paper is more convenient for use than Congo solution, though also much less delicate in response to free acids. Of the solution, a droplet added to a drop or so of the gastric filtrate, develops a violet or blue coloration depending upon the amount of free acid present—violet, if a minimum. 0.001 HCl and 0.002 lactic acid in *aqueous* solution are thus shown with certainty. With Congo paper but 0.01 HCl and 0.03 lactic acid respond to similar solution. See Leo: Diagnostik der Krankheiten der Verdauungsorgane, p. 92.

sodium hydrate,[1] a drop or two of a weak alcoholic solution of phenol-phthalein being first added as the indicator. A persistent, very faint red tinge shows neutralization. The total acidity is calculated on 100 c.cm. of stomach-contents. One hour after Ewald's trial-breakfast this should be between 20 and 60, equaling an acidity which, if due to HCl alone, would represent 0.07 and 0.21 per cent.

The presence of acid salts or free acids, may be determined by Congo paper as already stated, but, more delicately, by Leo's $CaCO_3$ test. A few drops of the filtrate are thoroughly mixed in a watch-glass with a little dry powdered $CaCO_3$ (C. P.).[2] After complete neutralization of the free acids of the filtrate, and disappearance of dissociated CO_2, the reaction is taken with blue litmus paper and carefully compared with that of the original unneutralized filtrate. A simple *lessening* of red coloration shows the presence of both free acids and acid salts. Its total

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[1] $\frac{N}{10}$ NaHO = 4 grams NaHO dissolved in 1000 c.cm. distilled water. Each c.cm. of this solution exactly neutralizes 0.0036 grams absolute HCl. The number of c.cms. consumed in the titration, multiplied by 0.0036, would represent the percentage of HCl contained in 100 c.cm. of the gastric filtrate, if the only acid present were HCl. The titrating solution is slowly dropped, with constant stirring, from a burette graduated in one-tenths of c.cm.

[2] $CaCO_3$ in cold solution neutralizes free acids only, not reacting with acid salts. This test is very delicate. Its application, after removal of fatty acids by heat, and lactic acid by agitation with ether, is the most certain and sensitive test known for free HCl. According to Leo, 0.002 per cent. of the latter may be detected by it if decided amounts of acid phosphates are not present; even then 0.008 per cent. HCl may be shown with exactness.

disappearance indicates positive absence of acid salts.

In examining for free HCl only those tests should be employed which respond to a mineral acid. For this reason Congo, methyl-violet, benzo-purpurin, 6 B., tropeolin (00), and other similar color reagents and combinations are not to be preferred to Günzburg's or Boas's[1] solution. Of these last, Günzburg's solution is a trifle more delicate; and as it may also be employed for the quantitative determination of free HCl (Mintz method) it is to be selected. Günzburg's solution consists of 1 part of vanillin, 2 of phloroglucin, and 30 of absolute alcohol. One or two drops of the gastric filtrate, with one of the test-reagents, are gently heated over an alcohol or Bunsen flame on a porcelain dish. On slight evaporation, a delicate rose-red tinge appears at the margin of the liquid, and promptly becomes of an intense cherry-red, depositing minute crystals of a similar color in the presence of decided amounts of free HCl. With the usual percentage of free HCl present, one drop of gastric filtrate may be diluted upward of fifteen times, and yet a drop of

[1] Günzburg's solution spoils more readily than Boas's. It should be prepared only in small quantities, and kept in a black, tightly-stopped bottle. Boas's solution consists of re-sublimed resorcin (5), sugar (3), dilute alcohol (100). Its application is identical with that of Günzburg's. Should response to Congo paper not occur, it may be necessary to gently evaporate several drops of the filtrate to obtain a reaction with these tests, and then but a fleeting red at the circumference may be produced, denoting minute traces only of free HCl. For percentage of delicacy of response of these tests and interference therewith in other solutions than aqueous, see my paper, Hare's System of Therapeutics, ii, pp. 897, 898; and Leo, loc. cit., p. 98 et seq.

this dilution will be found to respond to freshly made Günzburg's solution.

Freshly prepared Günzburg's solution forms an easily applied quantitative test (Mintz's)[1] for free HCl which is sufficiently exact for clinical purposes. Ten c.cm of the filtered or unfiltered stomach-contents are carefully titrated with deci-normal soda solution from a burette until a response no longer occurs with Günzburg's reagent. With the addition of each $\frac{1}{10}$ c.cm. or fraction thereof, depending upon the amount of free HCl suspected to be present, a drop or two of the partly neutralized contents is tested with Günzburg's solution.[2] The limit of the Günzburg's reaction being approximately 0.036 pro mille of HCl, an estimation of the percentage of free HCl is made by the multiplication of the number of c.cm. and fraction thereof at which the response just ceases, by 0.0036.

Examination for organic acids—lactic and fatty.[3] —Lactic acid is detected by the addition of a few

[1] Mintz: Wiener klin. Woch., 1889, No. 20; 1891, No. 9; and Martius and Lüttke's Die Magensaüre des Menschen, pp. 90, 91.

[2] If Mintz's test is applied after the total acidity is reckoned, and an account has been taken of organic acids and acid salts, an approximate idea may be formed of the quantity of soda solution required, so that too frequent repetition of application of Günzburg's test may be avoided during titration. If, however, only a small quantity of stomach-contents is obtainable, the test may be at once applied in the manner directed to the 10 c.cm. from which the total acidity is calculated, great care being then observed in the addition of the neutralizing solution.

[3] Space does not here permit detail of methods for estimating both the combined and free HCl, less necessary of calculation than the latter alone. Unfortunately, of the many proposed and in use, none is without elements of fallacy; those that are regarded as

drops of the gastric filtrate to Uffelmann's carbolated ferric chlorid solution,[1] or to a very dilute solution of ferric chlorid[2] alone, in a test-tube; the amethyst-blue color of the former solution is at once transformed into a yellow, and the light, almost colorless, yellow of the latter will be intensified in the presence of traces of lactic acid. Unfortunately, glucose, acid salts, and lactates also respond to the carbolated ferric chlorid test, and lactates and peptone to its modification, the ferric chlorid. A positive reaction occurring, therefore, a second step is necessary. A small quantity of the filtrate—about a dram—should be thoroughly agitated in a test-tube or separating funnel with about three or four times this amount of neutral ether. When great delicacy of result is especially desirable, as in removing all traces of lactic acid prior to testing for free HCl by calcium carbonate, several fresh portions of ether should be used. The ether is on each occasion removed by a pipette, if a separating funnel has not been employed for agitation. It is subsequently evaporated on a capacious watch-glass or porcelain dish, on a water-bath or in the air, and an aqueous solution of the ethereal extract tested by

freest from error, and which I usually employ, are Salkowski's modification of Sjöqvist's method (Zeitschrift f. physiolog. Chem., 1888; Bd. 13) and Leo's (see his Diagnostik, etc. or Martius and Lüttke's Magensaüre).

[1] A dilute solution of neutral iron chlorid containing a drop of carbolic acid.

[2] So dilute as to be almost colorless. For comparison of result, a second test-tube is filled with a similar solution to which an equal quantity of water is added, as of filtrate to the first. The colors of the two are carefully compared.

Uffelman's solution, which with these precautions becomes the most delicate reagent for the detection of lactic acid.

The fatty acids may be very simply detected by heating to the boiling-point a few c.cm. of the filtrate in a test-tube, over the mouth of which is suspended a strip of moistened neutral or blue litmus paper. Traces of these acids may be thus recognized.

The presence of free HCl indicates, beyond doubt, also the presence of pepsin. In the absence of response to tests for the former, the presence of the milk-curdling ferment also signifies the existence of pepsin. Response to the digestive test is also a certain indication of the secretion of both pepsin and HCl. A small disc of hard-boiled white of egg, or a similar quantity of purified blood-fibrin[1] is placed in one or two drams of the filtrate in an incubator maintained at a temperature of about 100° F. The albumen should be dissolved in from one to three hours, if pepsin and the normal percentage of HCl are present. If absence of or a deficiency in HCl exists, this acid should be added until, roughly, a percentage of from 0.1 to 0.3 is reached.

The presence of proteoses (albumoses or propeptones) also indicates the presence of peptone, for, although HCl alone apparently possesses the power to form a small amount of proto-albumose as well as syntonin, its secretion without the coincident appearance of pepsin seems impossible.

[1] Blood-clot is repeatedly washed until all trace of blood-coloration is removed. It is then preserved in glycerin, which latter is first removed from the test-portion used, by repeated washings.

Until recently it was thought that peptone was formed in abundance in the stomach, as a result of pepsin-HCl digestion, and that this, indeed, was the true end-product of the same. The researches of Kühne and Chittenden[1] tend to indicate that this is not the case; that but a minimum amount of true peptone is actually formed even through the long-continued action of pepsin-acid.[2] Bodies intermediate between syntonin and peptone seem to be largely the actual final product of peptic digestion, if one may judge by the relative amount of these and of peptone formed. The proteoses or albumoses are at least three, pro-albumose, hetero-albumose, and deutero-albumose; each of which in the order named progressingly approaches peptone. After neutralization of the acid filtrate, which precipitates syntonin or acid-albumin, and the removal of the latter, it had been thought, until Kühne and Chittenden's observations showed the contrary, that the primary products of digestion could be removed by the addition of sodium chlorid and strong acetic acid. Recently these experimenters ascertained that at least deutero-albumose is not thus precipitated, and that even proto-albumose and hetero-albumose are incompletely precipitated unless the sodium chlorid be present to saturation—so that the body termed "peptone" in the past has been variously deutero-proteose alone or a mixture of the proteoses, or of proteoses and peptone.

[1] See Chittenden: "On the Relative Formation of Proteoses and Peptones in Gastric Digestion." Journ. of Phys., vol. xii, No. 1.

[2] Unlike what occurs in consequence of pancreatic digestion of albuminoids, as a result of which peptone is readily formed without the intermediate albumose stages.

At the height of normal gastric digestion, one hour after Ewald's trial-breakfast, little or no cloudiness should occur on boiling and on neutralization of the gastric filtrate, showing absence of undigested albumin and of syntonin. These, if present, are removed by filtration. The colorless filtrate may then be at once acted upon by *neutral* ammonium sulphate, which in hot saturated solution almost entirely removes all traces of the proteoses; or, the filtrate may be first treated with cold saturated solution of sodium chlorid and strong acetic acid, which precipitates proto-albumose and hetero-albumose. Finally, deutero-albumose and traces of the other albumoses remaining may be precipitated by saturating the neutralized filtrate while hot with ammonium sulphate. The resulting ammonium sulphate filtrate should then be examined for peptone by the biuret test.[1]

In a considerable number of tests for peptone so applied, at the height of gastric digestion, my experiments are confirmatory of the test-tube experiments of Kühne and Chittenden. I have, indeed, rarely found more than traces of peptone, and frequently have been unable to obtain the biuret reaction in subjects in whom the digestive secretion otherwise responded normally. In these, proteoses were present in abundance, with no traces of undigested albumin and but little syntonin.

[1] The filtrate should be treated with a sufficient quantity of a strong potasium hydrate solution to decompose all ammonium sulphate present (see Chittenden, loc. cit.). Succeeding this, a drop or two of a very weak cupric sulphate solution should be added. The presence of peptone is shown by a purple-red color, varying to blush-violet, depending upon the amount present.

The presence of the milk-curdling ferment—an enzyme apart from pepsin and not related to HCl[1]—is readily ascertained by the addition of a few drops of gastric filtrate to about a dram of unboiled milk; this placed in a warm chamber solidifies in from a few minutes to an hour.[2]

Starch is readily detected in the stomach-contents by the blue coloration resulting when the filtrate is tested with Lugol's solution. The presence of erythrodextrin, a primary stage in the conversion of starch into maltose, is shown by a purple or brown hue developed. Achrodextrose, maltose, and dextrose, more advanced stages of the hydrolysis of starch, do not react to solutions of iodine. It is useless to test for grape-sugar, as this preëxists in the roll eaten.

The estimation of the propulsive functions of the stomach is of great diagnostic, prognostic, and therapeutic importance. It is most conveniently tested by salol, the method of Ewald and Sievers. This method furnishes fairly accurate results and is readily applied,[3] unlike the method, proposed by Klemperer,

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[1] The characteristic solidification of milk under the action of the ferment rennin must not be confounded with the fine, flaky coagula resulting from acids.

[2] Should coagulation not occur at the expiration of the specified time, rennin is probably absent, though its pro-enzyme, lab-zymogen, may not be. A small quantity of concentrated solution of $CaCl_2$ is added to the mixture, which is again placed in a warm chamber. Solidification now resulting indicates the existence of lab-zymogen, which, through the action of the $CaCl_2$ added, generating HCl, is transformed into the active ferment.

[3] Fifteen grains of salol in water are administered shortly after an ordinary meal. The urine is tested for salicyluric acid, be-

with oil. It is, however, unfortunate that hyperacidity due to increased secretion of HCl, which often occasions and accompanies gastric hypermotility, may cause delay in the intestinal decomposition of salol, and thus mislead, the result of the test suggesting the reverse condition—hypotony. Therefore, in instances of hyperacidity with delay in salicyluric acid response, in which a study of the propulsive function is of importance, Leube's method also should be tried—that of washing out the stomach and inspecting the removed contents for food elements from six to seven hours after a trial-dinner, or two hours and a half after Ewald's trial-breakfast, at the expiration of which period the stomach should be empty. The condition of the absorbent function of the stomach, of much less importance than the propulsive or secretory, is ascertained by the method of Penzoldt and Faber. Two or three grains of potassium iodid, inclosed in a gelatin capsule, the exterior of which must contain no traces of the salt, are ingested with a little water, on an empty stomach.[1] Normally, rapid absorption of the iodid from the stomach occurs, iodine being detected in the saliva

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ginning half an hour after the ingestion of the dose, and continued at intervals of from fifteen to twenty minutes, until response occurs. A simple method is to moisten strips of filter paper with a few drops of urine, touching the moistened spot with a few drops of a 10 per cent. solution of iron chlorid. A violet color indicates the presence of even traces of salicyluric acid. This reaction occurs normally in from forty to seventy-five minutes.

[1] For more detailed account of estimating gastric motility see my paper in Hare's System of Therapeutics, vol. ii, p. 900 et seq.

in from six to fifteen minutes. Strips of starch-paper[1] are moistened with the saliva and then a drop of fuming nitric acid is added to the moistened spot —a bluish coloration shows the presence of iodine.

Of the three gastric functions the trend of opinion recently is toward regarding the propulsive as the most important. Diminution in it, however perfect the gastric chemism, is likely to lead to impaired nutrition and secondary secretory disturbance far more promptly and more frequently than is a mere diminution in chemism to affect gastric motility. The chief function of gastric digestion is that of peptonization of proteids, and yet, as has just been stated, true soluble diffusible peptone is, under the most favorable circumstances, formed to a very limited extent in the stomach, bodies intermediate between it and acid-albumin being largely the end-products of pepsin-HCl digestion. These are but slightly absorbable, dialyzing and diffusing with difficulty. Subsequently, through tryptic digestion, the proteoses are converted into soluble peptone. Carbohydrates, save that portion acted upon by the saliva and fats, are also subject to intestinal digestion. Milk is coagulated and subsequently partly peptonized in the stomach; but since a milk-curdling ferment is also secreted by the pancreas, the stomach may be said to possess no digestive function not existing in the pancreatic juice.

Proteolysis, the chief digestive function of the stomach, is so much more efficiently performed by the pancreatic juice, which also readily digests starches and fats, that the gastric secretory functions

[1] Filter-paper saturated with starch paste, and dried.

may be in entire abeyance for long periods, and almost perfect bodily nutrition maintained by duodenal digestion, provided the gastric motility remains normal. It must, however, be borne in mind that derangement of the secretory apparatus tends, as a rule, if prolonged, to lead to atony of the stomach, and this eventually to a catarrhal condition which may eventuate in atrophy of the gastric tubules. In this condition degeneration of the gastric muscle is likely to occur.[1]

The various disorders affecting the stomach are characterized by an alteration in one or all of the functions, the recognition of the condition of which has just been considered. Derangement of gastric chemism is the most common. The secretory alteration consists especially in either diminution or increase in the most important of the constituents of the gastric juice—hydrochloric acid. Diminution is usually accompanied by a lessening in the production of pepsin and rennet ferment, though these latter or their pro-enzymes[2] are never habitually absent from the gastric secretion, except in advanced atrophy of the mucosa, in which condi-

[1] Cases of this sort are not uncommon, though few have been reported, except in Germany. I have had one—a woman—under observation for a year and a half. Einhorn (Med. Record, June 11, 1892) reports four cases of so-called atrophy of the stomach—but for which he suggests the term *achylia gastrica*—under his notice for several years. Three of these remain well nourished. One is a robust male, aged forty years, in whom Einhorn believes the anacidity has probably existed from earliest youth.

[2] Pepsin and rennin probably do not exist in the secreting cells as active ferments, but as pro-enzymes, which are subsequently converted into the former by the action of certain substances, such as common salt and HCl.

tion the secretory function is, of course, totally in abeyance. Unlike the case with secretion of pepsin and rennet ferment, free HCl may be completely unrecognizable in various affections, such as carcinoma of the stomach,[1] and less often, though more frequently than is commonly supposed, in certain gastric disorders depending upon a neurosis and of reflex origin.

Diminution or even absence of HCl in the stomach sometimes occurs solely as a neurosis, in the hysterical and neurasthenic, and as a reflex gastric disturbance in many uterine disorders and during menstruation. Cases are also rarely encountered in which, with presumably a normal mucosa, and without evidences of ailments affecting the stomach reflexly, in which free HCl is much diminished or absent. Diminution in secretion of HCl also attends all acute febrile conditions, acute or chronic gastric catarrh,[2] whether primary or secondary to

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[1] Absence of free HCl in carcinoma of the stomach results from disturbance in the secretory function, originated in all probability by an accompanying gastritis, leading to generalized atrophy of the mucosa. Rarely, free HCl persists until death, despite the presence of carcinoma, and very exceptionally, especially in carcinoma originating from ulcer, free HCl is present in excess. In these cases the gastric mucous membrane, except in the immediate vicinity of the cancer, has been found normal, *post-mortem*.

[2] An apparent exception exists in cases of hypersecretion of HCl, in which a catarrhal condition of the mucosa may be produced by irritation of the highly acid gastric juice. This continuing, chronic gastritis with subacidity ultimately results. Occasionally, also, in cases of simple mucous catarrh in which probably no structural alteration in the specific secretory epithelium has yet eventuated, periods of plus secretion in HCl replace diminution n the same. This last, though contrary to the teaching of Ewald, is based on positive evidence in cases that I have carefully studi ed.

heart, lung, or other visceral disease, or to gastric dilatation.

Diminution in, or absence of, secretion of HCl is often accompanied by the presence of large amounts of organic acids and acid salts in the stomach; especially is this the case if lessened gastric motility permits undue retention of food; so that in chronic gastric catarrh and in gastrectasia, however arising, these acids are usually found in abundance at a stage of digestion in which free HCl should be the only acid detectable by tests commonly employed.

Hyperacidity of the stomach may be due to the undue presence of organic acids arising through fermentation of food. This condition is often encountered in gastric catarrh, dilatation, and carcinoma. Hyperacidity more commonly occurs as a neurosis, it being then due to the presence of an excessive amount of free HCl, in which condition organic acids are at a minimum. Hyper-HCl production may or may not be accompanied by hypersecretion. When the latter is present, many ounces of an active digestive fluid may be obtained from the fasting stomach, even when little or no manipulation has been used in its extraction. Hypersecretion of gastric juice may or may not be accompanied by hyperacidity, though it usually is. It occurs either continuously, in which condition many ounces may be obtained from the fasting stomach, or periodically, and then especially after the ingestion of food.